A PC BASED TOOL FOR MISSION PLAN PRODUCTION

Authors: Jean-Pierre JOLI, Clet YVEN

Address: CNES - ET/EO/ER/MP
18 avenue Edouard Belin
31055 TOULOUSE CEDEX
FRANCE

Abstract

A satellite positioning is managed according to a MISSION PLAN (MP) witch provides, on a minute accuracy basis, a chronological list of events and associated actions to be performed.
This tool, called MM2, is designed under WINDOWS environment.
EXCEL is used to provide the MP itself.
A VISUAL BASIC process then translate it into a graphic symbolic representation called Flight Plan (FP).
During operations, MM2 is also used to log the actual event dates and/or dated OPS MANAGER live comments.

Key words:
Operations Management.

Introduction

The MP is redacted and mainly used by the OPERATIONS MANAGER (OPS) to conduct operations.
To be safe it must be qualified during the simulation phase.
To be useful it must be **up to date**.
This implies an important OPS workload when updating is handily managed.
Definition of a tool aiming to reduce human participation to only design tasks was then started.
It resulted in the following main specifications.

This tool must:

- Be PC based,
- be run under WINDOWS environment,
- only use "on-shelf" firmware,
- accept input data in "character type" files,
- allow easy adaptation to various spacecraft's and tracking networks constraints,
- allow a quick delivery, within basically 5 at least 10 minute, of a tuned issue,
- provide partial or complete plan without operator intervention when production process is started,
- allow, during operations, actual event dates and/or OPS live comments recording.

An updating strategy was also chosen.

General conventions

On a time point of view, in MP, all events are related to a main time reference witch is booster lift-off.
MP is split down into a collection of time slices, roughly corresponding to the spacecraft physical orbit, called "orbit" and named by a mnemonic.
An orbit has its own time reference, itself related to the main.
Each orbit event refers to this orbit reference trough a main Count-Down (C/D). If necessary, secondary C/D can be set-up.
All times are in UTC.

Events are either information to give or action to do.
An event can be either

- "simple", when it needs only one MP line to be completely described, or
- "complex" when it is an organized lists of sub-events. Flight Control Procedures (FCP) and ranging session (LOC) are complex events. In a complex event, each sub-event has its own duration and is time related to previous and following sub-events. It is assumed to begin at time 0:0:0.

Entities involved are clearly named.

Application description

MM2 work is organized as follow :

- Tailoring of input data (TXT files),
- for one orbit: Merging, processing, sorting, formatting and print of results. When many orbits processing is requested the process is repeated.
- VISUAL BASIC processing to draw FP,
- Use in operations: All along, actual time and OPS live comments are logged. When orbit is completed an "as run" issue is produced.

Tailoring and creating Input data

As show in figure N° 1 here after, some input data files are available from external entities. They are supposed to be in a text format allowing direct Excel input. If not, a text pre-processing is necessary and can be done with a text editor, Winword for example.

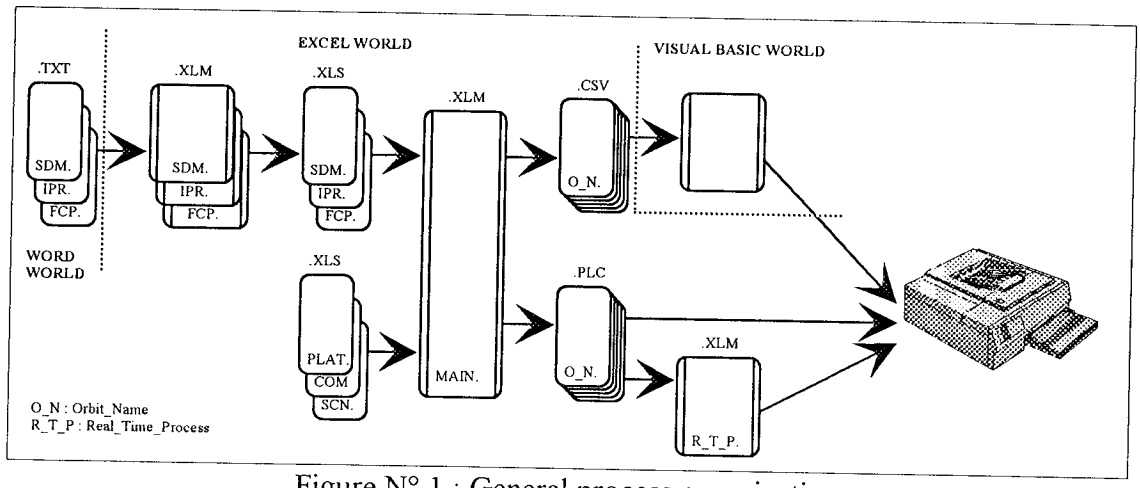

Figure N° 1 : General process organization

When under Excel, some complementary treatments are applied (tailoring). They mainly consist in:

- Shifting the right data to the right column,
- deleting not relevant lines,
- naming all significant data area to allow easy access later on.

Due to the fact that these data are supplied in various formats, three Excel specialized routines have been developed to make them comply with Excel main process input specifications:

- One for data coming from Flight Dynamics Center (tracking stations and sensors visibility's, eclipse periods, apogee date, etc.) witch deliver a file called SDM,
- one for data coming from Operational Orbit Center (interference predictions) witch deliver a file called IPR,
- one for data coming from Satellite Team (flight control procedures) witch deliver a file called FCP.

Some other necessary files are internally setup under Excel. They are :

- PLAT, in witch are stored general time references and orbits data base (ODB).
- COM in witch are stored pre-defined comments (witch are complex events), a model of orbit and page banner and the general GO/NOGO sheets.
- SCN in witch are stored the orbit scenari. A scenario describes work to do during a given orbit.

This last file is made out of dated lines witch can be:

- Free comments,
- reference to pre-defined comments (stored in the COM file),
- reference to FCP (stored in FCP file).

MAIN processing

Excel main program is working as follow :

First, read from PLAT file general time references and name of orbit to process.

Then by mean of the orbit name:

- Get from ODB:
  - The orbit reference name,
  - the orbit reference time,
  - the orbit "main operation to perform",
  - the first page number of orbit in MP.
- get from SDM and IPR files, data area related to orbit,
- process SCN one line at a time to:
  - Directly copy free comments to MP,
  - get and insert, from COM and/or FCP

Ref : TK.PN.52213.102.CNS — TURKSAT 1B — ISSUE 1, Rev.0 May 1994

Fore. UTC	True UTC	Main C/D	Action	Step description & comments	Sec. C/D
1994, Jul.21					
00:40		+01:59		S130-3 - Reconfiguration register	
			FDC	Display "SSH monitoring" (G6) on video page 4	
00:42		+02:01		S130-4 - Delete Time-Tag	
00:43		+02:02	OPS	***Announce end of S130 procedure***	
			OPS	Announce beginning of : **S140 - SOLAR ARRAY PARTIAL DEPLOYMENT** Duration 00:30 *OPS TM pages : S14SAPDP, EPS1* S140-1 - Initial configuration	
00:57		+02:16		S140-2 - Solar array partial deployment	
			FDC	Display "Sun reference coefficients for EAM" (M2) on video page 2	
			FDC	Provide SSR with "Sun direction prediction" (L2) by Fax	
			FDC	Send to SCC "Sun reference coefficients for EAM" (F1)	
01:11		+02:30		S140-3 - Trickle charge	
01:13		+02:32	OPS	***Announce end of S140 procedure***	
			OPS	LOC sequence with Perth	
			SAT	Set the ranging "ON" onboard the spacecraft	
			OPS	Request NOC to start a 5 mn full LOC sequence at Perth	
			NOC	Report beginning of LOC sequence at Perth	

NO_GTO_1 — Spacecraft Acquisition and Configuration — Page 205

Figure N° 2 : Mission Plan page example

to MP, pre-defined comment or FCP. In this last case, COM or FCP execution time is updated according to SCN specified time.

- sort MP on a chronological basis,
- Update time taking into account last known date and time,
- set main C/D,
- save MP in appropriate format for later Visual Basic processing,
- Format to give it, its definitive look as shown in figure N° 2.

VISUAL BASIC processing

At the end of the Main processing of an orbit, a specific file is created by Excel, and stored in a ".CSV" format. This file contains all the information needed to generate the FP.
The application developed under Visual Basic then allows to position and draw the elements of the MP on a time pattern as shown in figure N° 3.
One is able to get like this a quick (2 minutes for one orbit) and accurate graphical representation of the MP

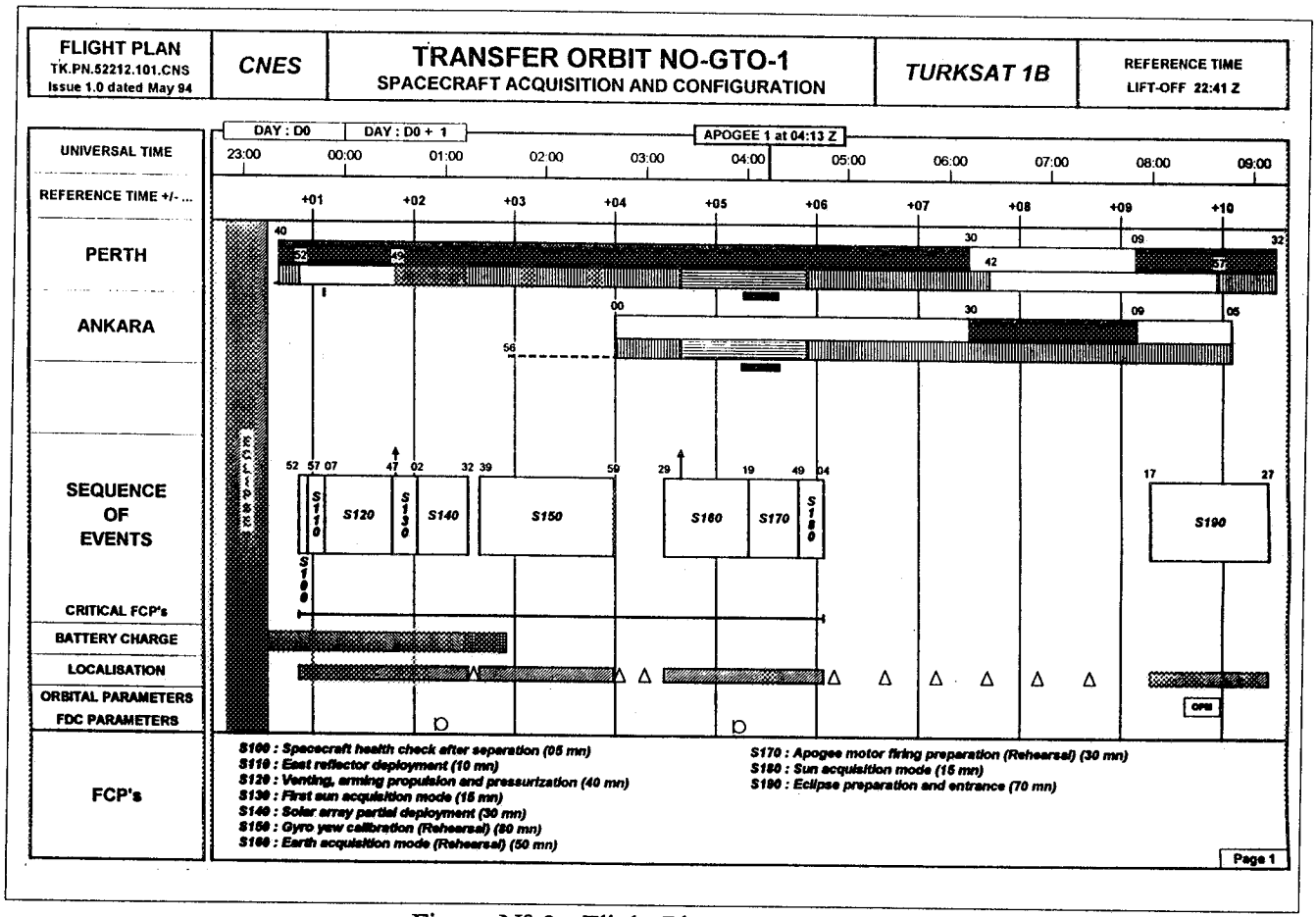

Figure N° 3 : Flight Plan page example

Real time processing

During operations a separated Excel program provides the following opportunities by simple click on the appropriate icon:

- Read PC clock and store sample in the right format at MP appropriate place,
- Insert dated lines logging live comments. These comments can be either input from the PC keyboard or pre-defined.

- when needed, finish the logging process and supply the "as run" issue.

Hardware environment

A 386 PC based configuration with a 5 Mbytes RAM, a 120 Mbytes mass memory and a laser printer is able to produce MP and to run it during operations.
However, at CNES TOULOUSE control center, due to presence of a concurrent Windows telemetry processing application on OPS workstation, we use a 486 based PC.

Software environment

Software environment is quite basic:
- MSDOS 5.0,
- WINDOWS 3.1,
- EXCEL 4,
- VISUAL BASIC 2,
- WINWORD 2,

Using MM2

When a project starts, first work is to "adapt" MM2 to the new environment.
That means :
- Select the appropriate language,
- tailor PLAT file according to positioning strategy and time,
- tailor COM file according to tracking network to be used and GO/NOGO format to apply,
- create the SCN file according to Spacecraft Operations Handbook (SOH) and general constraints,
- as soon as input data format is known and if necessary, modify the tailoring routines. When input data are available setup the Excel SDM, IPR and FCP files,

At this time, MM2 is ready to supply a MP and FP first issue witch will be used as support for Simulation and Rehearsal Phase (S&RP).
We can notice that this previous work, witch can be important, is usually done during calm periods.

Some updates, mainly concerning FCP and SCN, are done during S&RP. At the end MP and FP are qualified.
SDM data, taking into account last predictions for blinding or eclipse problems, is usually issued two weeks before launch. MP and FP are once more updated.

Since this time each update has to be quickly delivered (within 5 minutes).
According to update strategy, at a given time, only the next orbit update is mandatory.
Complete update, if necessary, can be slightly delayed.
As a consequence, an update of the first orbit is issued as soon as the actual launch date is known. It must be available before first spacecraft telemetry acquisition.
Then and if necessary, an orbit by orbit update can be initiated taking into account new orbit data as soon as they are available. This allow an accurate following of maneuver dispersions.

Conclusion

First use of MM2 was for HISPASAT 1B positioning. This spacecraft was spin and S band controlled in transfer. The MP was issued in English.
Since, MM2 has been adapted without any major difficulty, for TURKSAT 1B, witch is 3 axis and KU band controlled.
Today, adaptation to TELECOM 2C is in progress. In this case the main change is that MP will be issued in French.
This clearly demonstrate the flexibility of this tool.
On an efficiency point of view, at this time, we only have experienced slight deviations from nominal launch and maneuver performance. All goals were then reached.
However, we are presently reflecting on an "assistance to design" program witch could allow improved performance as well as coherence controls in case of major problem requiring a quick and complete MP reorganization.